Ohio Agricultural Experiment Station.

BULLETIN 114.

WOOSTER, OHIO, JANUARY, 1900.

HOW INSECTS ARE STUDIED AT THE OHIO AGRICULTURAL EXPERIMENT STATION.

The Bulletins of this Station are sent free to all residents of the State who request them. Persons who desire their address changed should give both old and new address. All correspondence should be addressed to

EXPERIMENT STATION, WOOSTER, OHIO.

COLUMBUS, OHIO
FRED J. HEER, STATE PRINTER
1900

ORGANIZATION OF THE

OHIO AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL.

R. H. WARDER	North Bend
J. T. ROBINSON	Rockaway
HON. L. M. STRONG	Kenton
THE GOVERNOR OF THE STATE THE DIRECTOR OF THE STATION	*Ex officio*

OFFICERS OF THE BOARD.

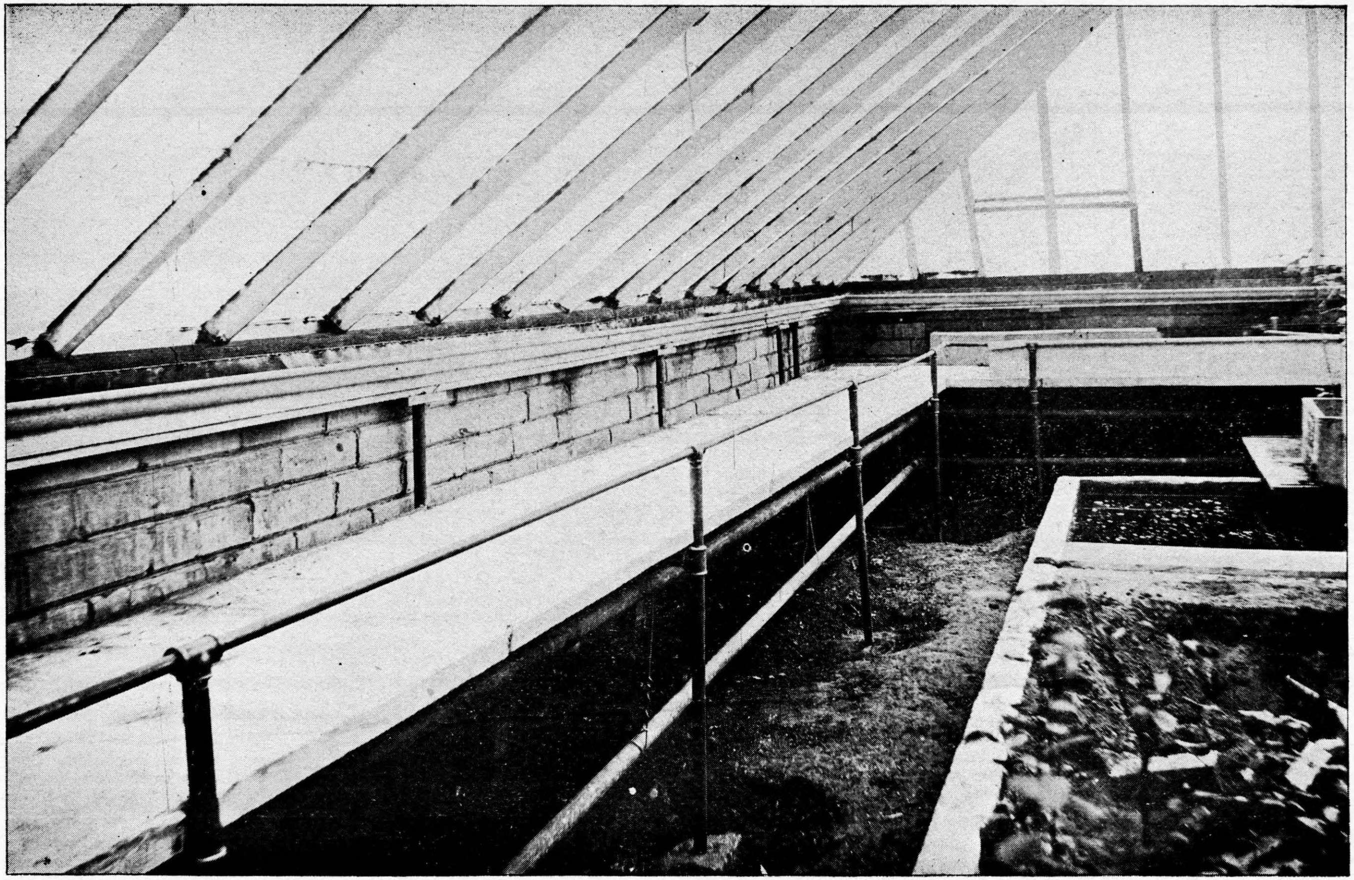
J. T. ROBINSON	President
R. H. WARDER	Secretary
PERCY A. HINMAN	Treasurer

STATION STAFF.

CHARLES E. THORNE	Wooster	Director
WILLIAM J. GREEN	"	Horticulturist and Vice-Director
J. FREMONT HICKMAN, M. A. S.	"	Agriculturist
FRANCIS M. WEBSTER, M. S.	"	Entomologist
AUGUSTINE D. SELBY, B. SC.	"	Botanist and Chemist
PERCY A. HINMAN	"	Bursar
JOHN F. HICKS	"	Assistant Botanist
WILMON NEWELL, M. SC.	"	Assistant Entomologist
WILLIAM HOLMES	"	Foreman of Farm
CHARLES A. PATTON	"	Ass't Foreman and Meteorologist
ANNIE B. AYRES	"	Mailing Clerk
CARY WELTY	"	Mechanic
EDWARD MOHN	Strongsville	Supt. Northeastern Sub-Station
LEWIS SCHULTZ	Neapolis	Supt. Northwestern Sub-Station

The Bulletins of this Station are issued at irregular intervals. They are paged consecutively, and an index is included with the Annual Report, which constitutes the final number of each yearly volume.

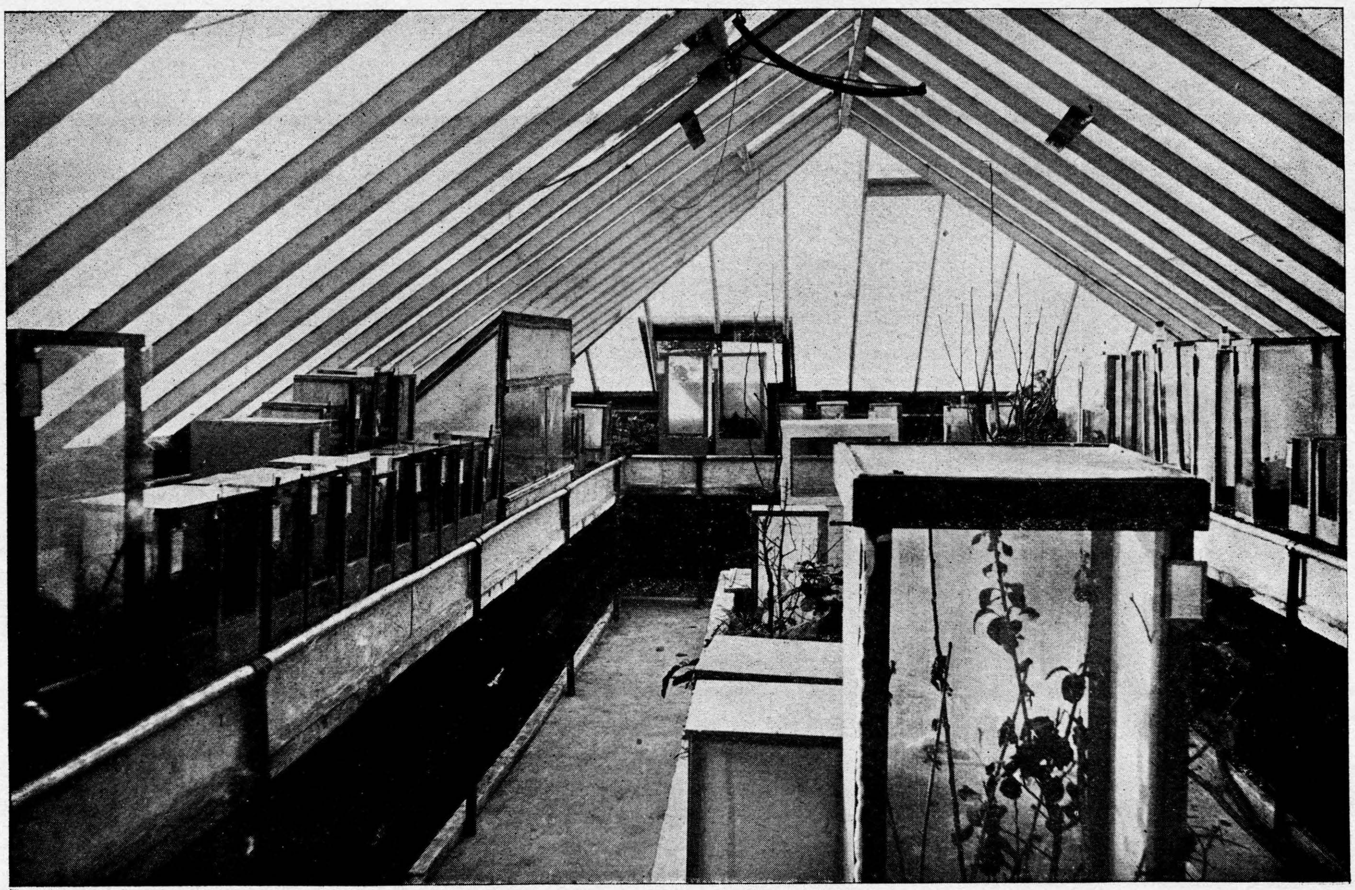
PLATE XVIII.



Interior of Insectary showing construction of benches.

This page intentionally blank.

PLATE XIX.



Interior of Insectary showing completed benches and breeding cages in use,

This page intentionally blank.

BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 114. JANUARY, 1900.

HOW INSECTS ARE STUDIED AT THE OHIO AGRICULTURAL EXPERIMENT STATION.

PLATES XVIII, XIX.

BY F. M. WEBSTER.

The object in publishing this bulletin is to show the farmer and fruitgrower, who is unable to visit the Station and see for himself, just how we study insects, closely and accurately, and how the information thus secured is adapted to practical application in field, orchard or garden. This kind of investigation is too often looked upon as more technical than practical, as, indeed, it would be were it not for the fact that, sooner or later, it is all submitted to the crucial test of practical field application.

With the constantly increasing activity in applied entomology in America, the necessity for rooms or apartments especially adapted to the study of the development of insects is becoming each year more imperative. The insectary has, in fact, become almost as necessary to the working entomologist as has the laboratory to the chemist. While it is especially true in entomological investigations that one must "study nature where nature is," it is equally true that one cannot, in all cases, watch with the necessary care and constant application in the fields that he will be able to do in a fairly well equipped insectary. Not only can insects be transported thousands of miles, while in an inactive state, and their development watched at close range, as it were, but eggs and larvæ may be brought in during late autumn or winter, and studied through their various stages, frequently long before they have appeared outside; and in cases of uncommon or unfamiliar forms this will give the investigator a vast amount of information that he can use to great advantage when the species appears in the fields under natural conditions, perhaps months later. We are at present studying the onion Thrips in this way.

When any demand has arisen for certain facilities, in order to study any particular species of insect, and this has constantly been the case, the ingenuity of myself and my assistant has been drawn upon to devise the best methods of accomplishing this end, and thus our insectary has come into existence.

Farmers will readily understand the impossibility of transporting a whole wheat field, or a whole meadow, across the state to Wooster, and there are few indeed who will not comprehend the difficulty of watching an insect in the field, closely, throughout the months of its life cycle.

Insects are more often destructive in the young or undeveloped stage, like caterpillars and grubs, and these young often have no more resemblance to the fully developed insects than a young wheat, corn or oat plant has to the kernel of these grains. For this reason, the young of insects must frequently be reared, just as many varieties of fruit trees must often be fruited before we can tell just what they are. Thus, the studies of injurious and beneficial insects are carried out closely in the insectary, and more widely in the field. Besides, we are often able to test remedial and preventive measures, in a small way, in the insectary, and frequently learn what will *not* be worth trying in the fields. It is well known that most insects have some weak point in their life, or, in other words, there is usually some phase of their development which, if understood, will give us an advantage in overcoming them. This we can frequently learn in the insectary. The insectary thus becomes a sort of a searchlight, to enable us to see more clearly in the fields.

The insectary, proper, is constructed much after the plan of an ordinary greenhouse The walls are made of hollow tile, and the movable sashes in the roof, for ventilating purposes, are enclosed in dormer-like, wooden frames, covered with swiss or a very thin cotton sheeting, in order to prevent the introduction or escape of the most minute insects. A door at one end opens into a workroom, while a window in the roof at the other end is provided with a protected, movable sash, like those previously mentioned.

Along three sides extends a bench, such as are in use among florists, except that, in this case, it is only about 30 inches in width, to facilitate the close examination of objects at the far side. A portion of the central space is occupied by a reservoir, where, originally, we had a wider bench.

Wooden benches were tried at first, but these soon decayed, while it is well known that the larvæ of many species remain long in the earth and to disturb them is fatal, so we were obliged to cast about for something more stable to meet these requirements. We are now using, with apparently perfect success, a bench, the construction of which is shown in Plate XVIII. The bottom is of ordinary stone flagging, two inches in thickness, and supported on a frame work made of ordinary gas pipe. The upper side of this flagging is deeply grooved, about an inch from the edge, along each side. For the back of the bench ordinary roofing slate is used, the lower edges being fitted into the groove in the stone and embedded in cement, while the upper edges are held in place by a cap of galvanized iron, running along the entire length. For the front a heavy galvanized sheet iron is used, the lower edge, as with the slate, fitting into the front groove in the flagging, while the upper is drawn over and turned under the smaller, horizontal gas pipe, the latter being held in place by a T joint, all of which is shown in the background of Plate XVIII. Before filling the benches, the inside of the galvanized iron front is coated with asphalt.

The wider, central bench was discarded altogether and the space enclosed by a low brick wall, plastered with cement. This enclosed space is filled with earth and will accommodate shrubs and even small trees.

The finished benches, with the whole apartment in actual service, are shown in Plate XIX. Formerly, we placed soil in the breeding cages, and grew, or tried to grow, the food plants of whatever insects we happened to be studying therein; but the plants seldom thrive well under such conditions, and the effect on the insects feeding thereon is unsatisfactory and in many cases fatal. Especially is this true where it becomes necessary to transplant from out of doors, as it frequently occurs that we wish to transfer a plant with the larvæ feeding upon it, to a position that will enable the movements of the latter to be carefully studied. Under the new arrangement we can either grow the food plant in the benches, or transplant it from the garden or field, place our insects upon it, and cover with a breeding cage, thus eliminating to a considerable extent the objectionable features of the old method. Or, if we find an insect attacking a plant out of doors, we can place over the plant one of the cages, of the pattern that we are now using, and pushing the metal base into the soil, deftly inclose the whole within our cage without in the least disturbing the insects that we wish to study under the most natural conditions possible.

The breeding cage now in use is shown in Figure 1, and also in Plate XIX. It consists of a wooden frame of four upright pieces, supporting a wooden top, and with an upper base, also of wood. Three sides are covered with swiss drawn tightly and fastened along the edges with galvanized iron strips about one-fourth of an inch in width, and these are in turn fastened to the wood by tinned staples, such as are used in laying carpets and matting. The remaining side is of glass, which is raised and lowered as required, and works in vertical grooves. By using galvanized iron strips and tinned staples the rusting out of the swiss or other cloth covering is avoided. The lower base is also of galvanized iron, and is shown in Fig. 2, as is also the wooden bottom which fits inside of this. The latter can be used when needed, and when not may be readily removed and laid aside, as it is fastened in place by screws. When used without the bottom it is only necessary to place the cage over the plant, or plants, and press it down until the metal portion is sunk into the soil. The cage can be used out of doors as well as in the insectary, and without materially affecting the plant or disturbing the

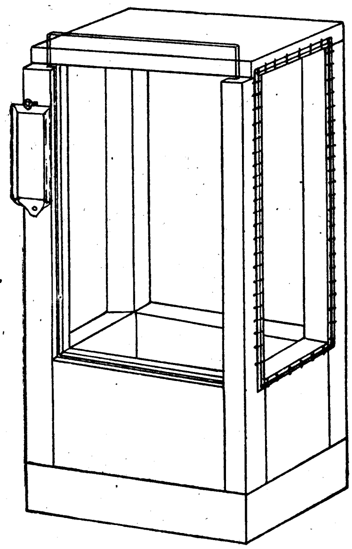


Fig. 1.

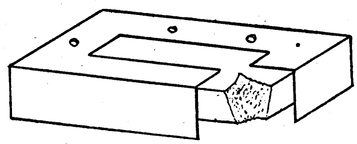


Fig. 2.

insects feeding upon it. When used with the wooden bottom the metallic base raises this above the damp soil, thus preventing the decay of the lower portion of the cage.

But "the one supply reveals another want," and we soon found that there was need of some method of keeping our notes and records conveniently attached to the proper cage to which they belonged, as well as to protect them from being wetted whenever the benches were wet down with the hose. This led to the use of a holder of galvanized iron, with a sliding glass front, fastened to the cages as shown at the left in Fig. 1, and also in actual use on the cages in Plate XIX. The holder is two by three inches, the sides turned over, and one end folded over these, while the other end is left a little longer and rounded, with a small hole to pass over a small nail or brad, while the folded end is held by a small screw-eye, such as are used on picture frames to which to attach the ends of the cord or wire. The note sheet is folded the proper size and placed in the holder, and the rather close-fitting glass slide pushed in over it. The sheet is so folded that all of the notes will come on the same side, and each space or page is consecutively numbered, and, being all of a uniform size, these sheets, when filled, or the record finished, can be filed away for permanent preservation. This holder cannot easily become detached from the cage to which it is fastened, the notes are preserved from being injured by wet, the galvanized iron does not rust them, and the last record can always be seen through the glass cover without removing it from the cage. With slight modifications, this holder can also be used out of doors on shrubs and trees. For this purpose, what shows as the lower end in Fig. 1, is cut square off and a similar triangular piece is soldered to the back of the upper end, to accommodate a fine wire, which is used not only to attach the holder to the object, but the end running downward along the back is hooked over the lower end of the holder, thus effectually preventing the glass slide from being shaken out by the action of the wind. On cages outside it is of course used in the same way as in the insectary.

Let us suppose that Farmer A sends us some destructive worms that we do not recognize. As soon as these are received they are, perhaps, given a number, precisely as is a new convict when he reaches the penitentiary, only in this case instead of giving the recipients of this number a cell, they are given a breeding cage, like the one shown in Fig. 1, with a supply of food. In the book in which this number is recorded are spaces left for the name, when this is learned, date of sending, name and postoffice address of sender, with the number of letter file in which all of his letters relative to the insects sent are kept, as will be more fully explained. Thus, not only are his letters easily found, but all of the information that we possess relating to the insect sent can be brought together in a few minutes, and this can also be done fifty or a hundred years hence.

Regarding the material that comes into the insectary, this is, of course, derived from two sources: First, that of our own collecting, and which may come from all parts of the state; and second, that which is sent to us by correspondents, and which comes largely from the state in which we are located, but may come from almost anywhere. Such insects as do not require leafy plants upon which to feed, or such as have passed into the pupal stage and require no food, excepting such insects as are found in limbs and trunks of trees, we manage by the old method of keeping them in jelly glasses. For such as require a limited amount of food, and especially where we wish to watch their movements very closely, we use the ordinary glass cylinders, known as chimneys for the Argand gas burners. These are about two inches in uniform diameter and five inches in length. We find these preferable to ordinary lamp chimneys, as they are of better quality of glass and less easily broken. These can be placed over plants, either in the benches in the insectary, or when the plants are growing in ordinary flower pots. The top of the cylinder is covered with a thin muslin held down with glue or asphalt. Whatever preparation is used for this purpose should be insoluble in water.

For insects that require much food, and for which a large amount of leafage is consequently necessary, we employ larger breeding cages. We have certainly found it much more satisfactory to transplant food plants to the benches of the insectary, and better yet, where possible, to grow these plants in such situations, as the food supply for the insects is thus in a more natural condition than can be made possible if the food is simply gathered and placed in the old-style breeding cage with an immovable bottom. Where possible to do so, I make it a point to grow food plants in the insectary, and thereby prevent the accidental introduction of other forms into our breeding cages, which, very often are exceedingly annoying, and nearly or quite vitiate results that have cost much time and attention.

When material is brought into the insectary, it is seldom given an "accessions catalogue" number at first, but is placed in jelly cups or cages and a slip is attached thereto, giving date of reception and locality from which it came. In case nothing develops worth recording, then we have saved loading down our accessions catalogue with unnecessary numbers. But as soon as any developments are noted, as, for instance, the appearance of parasites, or the further transformation of any of the insects included, we then enter the material in the accessions catalogue, number it, and attach this number to the cup or breeding cage, as the case may be. As soon as the material is taken from the cages, or from the jelly cups, it is pinned and a label placed upon each pin, giving date of appearance and accessions catalogue number. If the material has come from elsewhere besides the Experiment Station, or immediate vicinity, the exact location, as nearly as we can obtain it, is indicated on the pin on the second label. That is, we would have on one label, "Insectary, 6-5-'99," which signifies that the specimen appeared June 5, 1899. Either above or below this label would be another, which might read, "Toledo, O., 1-4-'99," which would indicate that the material from which the specimen developed was obtained at Toledo, on the 4th of January, 1899. This prevents the confusion between the date of collection and the date of appearance of fully developed specimen. If, as is sometimes the case, material is placed out of doors and there reared in breeding cages, we then give the original locality and date of collection on one slip and on another the locality and date where it was reared, so that there will be no confusion between the two. It is expected that breeding cages and breeding cups will be carefully inspected, at least once each day, and everything that has reached a condition where it is ready for permanent preservation is removed, although it frequently occurs that cups or cages may have to be examined several times each day in order to prevent insects which are developing in them from becoming rubbed or otherwise injured by attempts to escape.

For the rearing of such insects as bore in wood, and their parasites, we have had a special cage made. This is much like the ordinary breeding cage, except that the top, bottom and three sides are of wood. The fourth side is provided with a movable front, and for this we use a very heavy glass, very thickly painted with asphalt, so that after we have placed sections of limbs of trees in the cage and closed the front, the interior of the cage is entirely dark, excepting a very little light that is permitted to enter from a round hole made in the top of the cage, and over this we place one of the glass cylinders, previously named, the top of which is covered with muslin, as has been described. These glass cylinders are held in place by small spiral springs, made of brass wire, and arranged in such a way as to inclose the lower end of the cylinder about an inch from the end, the springs being held in place by small nails. By this means all insects that develop in the cage below on seeking the light make their way upward out of the cage and into the glass cylinder from which they cannot escape, but wherein they may be easily detected. When we wish to remove them we simply raise the cylinder slightly and push a bit of cardboard beneath it, thus shutting off the escape of the insect, and, by injecting a few drops of chloroform into the cylinder and covering the top, kill them almost instantly without in any way affecting the atmosphere in the compartment below. These cages are quite convenient, as they may be placed almost anywhere on a shelf or similar place, and it is only necessary to inspect the glass cylinders in order to determine whether or not anything has developed from the sections of wood beneath.

The accessions catalogue has been arranged in a way that, so far as known to me, is largely original. The left-hand page is divided into seven columns, each of which is filled out after the following manner:

The first, or the one nearest to the outer margin, is used to indicate the number of the bulletin in which the information relating to the species has been published, when this has been done; the second space contains the accessions catalogue number; the third space indicates the number and page of the journal containing the further records relating to the species; fourth, the name of the species; fifth, the locality from which it came; sixth, date of collection or of sending, if it has been sent us by a correspondent; seventh, name of collector, or sender. This occupies the entire left-hand page, while the right-hand page is divided into two spaces only. The first, or the one on the left, is quite narrow and contains the number of the letter file in which the letter accompanying the specimens, if sent by a correspondent, is filed, the remaining space being devoted to remarks, which include any short item that can be expressed in a very few words. All additional information outside of this is taken to the journal, and its position in the journal is indicated in the third space from the margin on the left-hand page, as previously stated. When the breeding notes are finished and revised they are transferred to the journal, as every one knows that original notes, in order to be of value, must contain a great deal that it is not usually necessary to use in print. In other words, the journal is supposed to contain the essential facts obtained regarding the species, together with such details as seem of sufficient importance to include.

The journal is arranged in this manner: Starting at the top of the page, first will be given the accessions catalogue number; following it on the upper line the food plant or other host, if such is known, followed by the name of the species, if we have it, and if parasitic the fact is also indicated. Below this is given the date of observation, and following this the note itself. It will be seen that by this means we are able not only to gather together all of the material relative to a single species, but also our own notes and records, even to the original slips that we have recovered from the cages or jars. Besides this, we can at once find not only the original letters from the parties sending us the material, but any replies we have previously made thereto. As I stated before, this sytem requires considerable book-keeping; but when we come to use our notes and correspondence, as well as to refer to the material, we find that it is but a very simple task to get it all together, and we here save much more time than we have expended in keeping our records.

In both our collections and breeding we aim, as much as possible, to get the exact locality from which the material came. Here, again, I have found considerable difficulty. Often a farmer may live anywhere from one to ten miles from his postoffice, and in these cases it is of course absolutely impossible to give exact localities, as his farm may lie several hundred to a thousand feet above his postoffice town, or the reverse may be true. The only way I have found to in part obviate this difficulty is to have a map of the state, showing not only the counties but the townships, mounted upon a back of thick board or plank of seasoned pine. With this mounted upon an easel near my desk, I have spread out before me the whole state. Then, if I can get a correspondent to tell me in what township he lives, and in what part of this township, I can get his location almost exactly. This map is exceedingly convenient in following out the spread or distribution of any species, as wherever it is discovered by either myself or my assistant, or wherever it is reported by our correspondents, we indicate the exact locality on our map by a small disk of colored paper, using different colored disks for different species of insects. In this way we can not only indicate in a very clear manner the spread of the species over the state, year after year, but we can also indicate the extent of more or less local outbreaks; as, for instance, in studying the distribution of the seventeen-year cicada in 1897, we used a small disk made from canceled 2-cent postage stamps, and wherever the cicada were observed or reported in a locality, we marked that locality by one of these disks, fastened to the map by a small tack. At the end of the season we have the entire distribution, so far as we are able to obtain it, directly before us, and have but to sketch this area on a base map, by the use of oblique lines, to get a drawing ready for the engraver. Again, as illustrating the second use, that of indicating local outbreaks, of course, there is the first report to go on. This will be indicated on our map by a single colored disk. If there is much destruction and the outbreak extends over any considerable territory, we shall very soon hear from a greater or less number of people within this area of destruction, and by indicating the location of these on our mounted map, we will, within a few days, be able to see at a glance just where the trouble is being experienced. In other words, we have the storm center, as a meteorologist would express it, indicated clearly upon our map. This takes but very little time, and I have found it a very great help, either in keeping track of the spread of insects that are known to be moving in some particular direction, or in showing the area covered by the outbreak of any pest. While it requires a little time to attach these colored disks, I think that this is more than saved when I come to prepare a drawing for the engraver, showing the area over which any species has extended or become seriously destructive. I do not know whether this scheme of mapping outbreaks and diffusions could be carried out on a larger scale on the United States map, but it seems to me that it could be used in such cases also, though perhaps in a more general way.

As before indicated, we look upon this work as preliminary to that carried out in the fields, where we have to encounter the same conditions as the farmer, and, therefore, we are enabled to give him the combined results of insectary and field experience and investigation. Not only this, but every fact that any farmer has given us is brought to bear on the problem to which it may relate, and thus all get the benefit. In other words, it is a mutual object lesson, wherein all information gained from any quarter is taken to the fields of the farmer and there before his own eyes he can see what is done, how it is done, and just what results are obtainable under the same conditions as he himself labors. Every one understands, perfectly well, the difference between having a method explained to him and seeing the method carried out. We can only investigate insect depredations in the localities where these occur, but we can and do very often, in the insectary, get information that enables us to take a short cut, so to speak, when we go to the fields to carry out this work.

This page intentionally blank.